Fail-safe circuit for gas valves

The invention relates to a fail-safe circuit for gas valves.

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Regulator devices for gas valves must be fail-safe. If the state of the regulator device is undefined, then it must be guaranteed that in this undefined state a gas valve controlled by the regulator device does not open.

10 If, for example, a microprocessor is used as the regulator device for gas valves, then the use of a fail-safe circuit guarantees that the whole arrangement is fail-safe.

15 Recently, piezo-operated gas valves have been used, particularly in low-voltage applications such as water heaters without a mains connection. The piezo-operated gas valves are controlled by a regulator device in the form of a microprocessor. In such low-voltage

20 applications, the supply voltage is approximately 3 volts, which can be provided by a battery. However, a voltage of at least 150 volts is required to open the piezo-operated gas valves. Accordingly, a fail-safe circuit is required for low-voltage applications of

25 this kind, which, on the one hand, provides an output voltage of at least 150 volts to open the piezo-operated gas valves from a low supply voltage of approximately 3 volts, and, on the other, only generates the output voltage required to open the

30 piezo-operated gas valves if the regulator device in the form of a microprocessor is in a defined state to open the gas valves.

Starting from this, the present invention is based on

35 the problem of creating a new kind of fail-safe circuit for gas valves.

This problem is solved by means of a fail-safe circuit

for gas valves with the characteristics of Claim 1. According to the invention, the fail-safe circuit includes at least one input that can be connected to a regulator device and at least one output that can be

5   connected to a gas valve, where the fail-safe circuit only supplies an output voltage that is required to open a gas valve to the or to each output if an input signal containing at least two different, successive frequency signals is applied by the regulator device to

10   an input of the fail-safe circuit.

In terms of the present invention, a fail-safe circuit is created for gas valves, in particular for piezo-operated gas valves, which, on the one hand, is able to

15   provide an output voltage of more than 150 volts that is required to open piezo-operated gas valves from a supply voltage of only approximately 3 volts, and, on the other, only provides this output voltage required to open the piezo-operated gas valves if the regulator

20   device is in a defined state to open the gas valves. The fail-safe circuit according to the invention is characterized by a simple design and can therefore be implemented cost-effectively.

25   According to a preferred improvement of the invention, the fail-safe circuit has a charging circuit and a voltage transformer circuit. The charging circuit has at least one capacitor, where the charging circuit charges the or each capacitor in the charging circuit

30   when a first frequency signal is applied or is present in the input signal. On the other hand, when a second frequency signal is applied or is present, the or each capacitor in the charging circuit discharges. The voltage transformer circuit produces an output voltage

35   that is required to open the gas valve from a supply voltage when the second frequency signal is applied or is present in the input signal. The voltage transformer circuit has at least one capacitor, which charges when

the second frequency signal is present in the input signal, and which discharges when the first frequency signal is present in the input signal, and hence maintains the output voltage required to open the gas

5   valve more or less unchanged.

Preferred improvements of the invention can be seen from the subclaims and the following description. An exemplary embodiment of the invention is described in

10   more detail below with reference to the drawing without being restricted to this. In the drawing

Fig. 1: shows a circuit diagram of a fail-safe circuit
       for gas valves according to the invention.

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The present invention is described in greater detail below with reference to Fig. 1.

Fig. 1 shows a fail-safe circuit 10 for gas valves

20   according to the invention, in particular in low-voltage applications. Possible examples of such low-voltage applications are water heaters without a mains connection in which piezo-operated gas valves are used. In such low voltage applications, a supply voltage is

25   provided from a battery or from a generator integrated within the water circulation, the supply voltage in such applications being about 3 volts. In Fig. 1 the supply voltage is identified with V_{BAT}.

30   In the preferred exemplary embodiment of Figure 1, the fail-safe circuit 10 according to the invention has an input to which a regulator device in the form of a microprocessor can be connected, and two outputs 12 and 13, from which a supply voltage $+/- V_{OUT}$ is output for a

35   gas valve. Depending on the signal from the regulator device, which is applied to the input 11 of the fail-safe circuit 10 of Fig. 1 according to the invention, the circuit generates the output voltage V_{OUT} that is

necessary to open the gas valve using the supply voltage V_{BAT}, which is approximately 3 volts, namely only when an input signal containing at least two different, successive frequency signals is supplied by

5   the regulator device to the input 11 of the fail-safe circuit 10.

The fail-safe circuit 10 of Fig. 1 according to the invention has a charging circuit 14 and a voltage

10   transformer circuit 15. The charging circuit 14 and the voltage transformer circuit 15 contain the components enclosed by chain-dotted lines in Fig. 1.

The charging circuit 14 of the fail-safe circuit 10

15   includes a capacitor 16, where two diodes 17 and 18 are connected in parallel with the capacitor 16. A resistor 19, which is connected to the input 11 of the fail-safe circuit 10 via a capacitor 20, is connected between the two diodes 17 and 18.

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As can be seen from Fig. 1, a transistor 22 is connected to the input 11 of the fail-safe circuit 10 via a resistor 21, the transistor 22 being designed as a bipolar transistor, namely as an NPN transistor. The

25   base of the transistor 22 is connected to the input 11 of the fail-safe circuit 10 by means of the resistor 21. Connected to the capacitor 16 of the charging circuit 14 is a further resistor 23, which in turn is linked to the collector of the transistor 22 and the

30   base of a transistor 24 of the voltage transformer circuit 15. The transistor 24 is in turn designed as a bipolar transistor, namely as an NPN transistor.

According to Fig. 1, the emitters of the two

35   transistors 22 and 24 are connected together. As well as the transistor 24 already mentioned, the base of which is connected on the one hand to the collector of the transistor 22 and, on the other, by means of the

resistor 23 to the capacitor 16 of the charging circuit 14, the voltage transformer circuit 15 furthermore contains a comparator 25, a coil 26, a diode 27, a capacitor 28, a resistor 29 and a further transistor 30. The transistor 30 is designed as a field effect transistor or a MOSFET transistor.

As can be seen from Fig. 1, the coil 26 is connected on the one hand to the supply voltage V_{BAT} and, on the other, to the so-called drain of the transistor 30, which is designed as a self-blocking field effect transistor. An anode of the diode 27 is connected between the coil 26 and the drain of the MOSFET transistor 30, whereas the cathode of the diode 27 is connected to the output 12. The source of the MOSFET transistor 30 is connected to the output 13, while the capacitor 28 of the voltage transformer circuit 15 is connected between the outputs 12 and 13 of the fail-safe circuit 10. As can also be seen from Fig. 1, the output of the comparator 25 connects to the gate of the MOSFET transistor 30 while the input of the same is connected to the collector of the bipolar transistor 25. Furthermore, the collector of the transistor 24 is connected by means of the resistor 29 to the coil 26 and thus to the supply voltage V_{BAT}.

As already mentioned, the fail-safe circuit 10 only generates an output voltage of over 150 volts that is required to open the gas valve at the outputs 12, 13 if a signal containing at least two different, successive frequency signals is provided by the regulator device at the input 11 of the fail-safe circuit 10. In this case, a defined operating state of the regulator device for opening the gas valve exists.

In the preferred exemplary embodiment, the input signal contains two frequency signals, namely a first frequency signal with a frequency of about 500 kHz and

a second frequency signal with a frequency of about 10 kHz, which are present or are applied successively in the signal provided by the regulator device in such a way that a time period of about 30 milliseconds with

5   the first frequency signal of about 500 kHz is respectively followed by a time period of about 100 milliseconds with the second frequency signal of about 10 kHz.

10   The fail-safe circuit 10 of Fig. 1 now works in such a way that when the first frequency signal of about 500 kHz is applied or is present at input 11, the charging circuit 14 charges the capacitor 16 of the same. While the second frequency signal of about 10 kHz is applied

15   to the input 11, the capacitor 16 of the charging circuit is not charged but rather a discharge of the capacitor 16 takes place via the resistor 23 and the base of the transistor 24. The transistor 24 of the voltage transformer circuit 15 is then conductive if a

20   current flows to its base due to the discharge of the capacitor 16.

During the time period for which the first frequency signal of about 500 kHz is applied to the input 11, a

25   high output voltage that is required to open the gas valve cannot be generated by the voltage transformer circuit 15 due to the high losses, in particular in the coil 26 and in the MOSFET transistor 30 of the voltage transformer circuit 15. Rather, this output voltage is

30   only generated when the second frequency signal with a frequency of about 10 kHz is applied to the input 11. When the second frequency signal of about 10 kHz is applied to the input 11, an output voltage V_{OUT} of more than 150 volts that is required to open the piezo-

35   operated gas valve is generated from the supply voltage V_{BAT} by the voltage transformer circuit 15, and the capacitor 28 of the voltage transformer circuit 15 is charged.

If a time period of about 100 milliseconds, in which the second frequency signal with a frequency of about 10 kHz is applied, is followed by a time period of about 30 milliseconds with the first frequency signal with a frequency of about 500 kHz, then the capacitor 28 of the voltage transformer circuit 15 discharges and essentially maintains the output voltage of more than 150 volts that is required to open the gas valve. The capacitor 28 discharges via the high resistance of the gas valve during the time period in which the first frequency signal with the frequency of about 500 kHz is applied.

The specific design of the circuit described above is incumbent upon the person skilled in the art addressed here. In the particularly preferred exemplary embodiment in which an output voltage V_{OUT} of about 250 volts is to be provided for opening the gas valve from the supply voltage V_{BAT} of about 3 volts, the capacitance of the capacitor 28 is preferably 1 μF, the capacitance of the capacitor 16 is about 10 μF and the capacitance of the capacitor 20 is about 220 pF. The resistance of the gas valve connected to the outputs 12 and 13 can be assumed to be 10 MΩ, the resistor 21 is preferably chosen to be 1 MΩ, the resistor 19 to be 1 kΩ and the resistor 29 to be 10 kΩ. The resistor 23 preferably has a value of 22 kΩ. The coil 26 preferably has an inductance of 1 mH. With these values, the discharge time of the capacitor 28 is about 10 seconds from which it immediately follows that an output voltage that is required to open the gas valve can also be provided at the outputs 12 and 13 during the time period of 30 milliseconds in which the first frequency signal of about 500 kHz is applied to the input 11.

List of references

	10	Fail-safe circuit
5	11	Input
	12	Output
	13	Output
	14	Charging circuit
	15	Voltage transformer circuit
10	16	Capacitor
	17	Diode
	18	Diode
	19	Resistor
	20	Capacitor
15	21	Resistor
	22	Transistor
	23	Resistor
	24	Transistor
	25	Comparator
20	26	Coil
	27	Diode
	28	Capacitor
	29	Resistor
	30	Transistor